Process Design and Economics of Bioethanol Technology Utilizing Dilute Acid Pretreatment and Enzymatic SSCF

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21st Symposium on Biotechnology for Fuels and Chemicals
Ft. Collins, Colorado
May 2-6, 1999

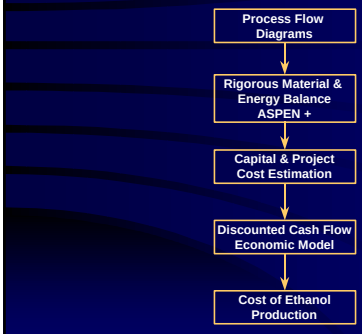
Overview

- Why Study Process Economics?
- NREL's Approach to Process Design & Economics
- Design Basis & Costs
- Anticipated Improvements & Costs
- Other Cost Sensitivities
- Continuing Work

Why Study Process Economics?

- Determine the Absolute Cost of Biomass to Ethanol Conversion
  - Useful for DOE funding decisions (Market Penetration)
- Determine Incremental Cost Improvements of Research Proposals
  - Guide research & development (evaluate potential for process improvement)

NREL's Approach to Process Design and Economic Modeling



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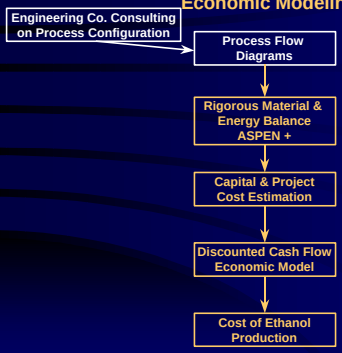

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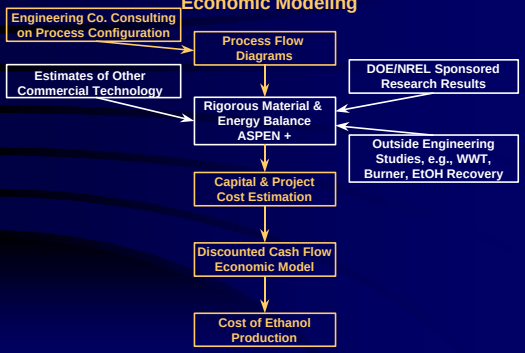

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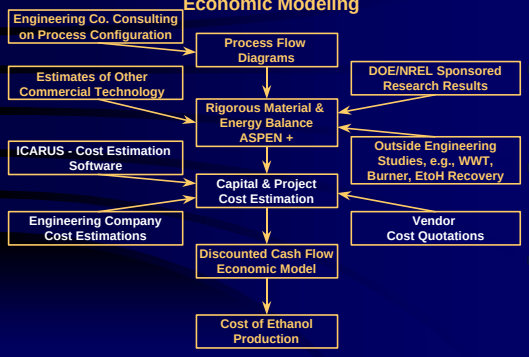


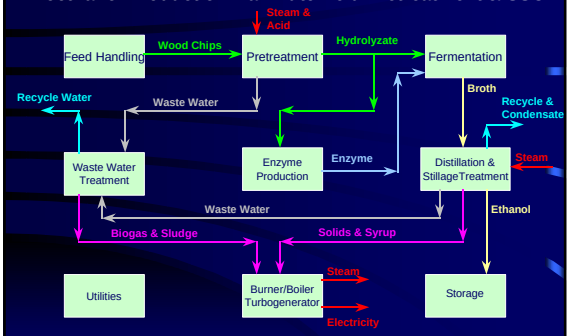
Feed Stock Selection

- Feedstocks of Current Commercial Interest
  - Various Softwoods
  - Corn Stover & Rice Straw & Bagasse
  - MSW
- Current Process Design - Yellow Poplar
  - Baseline Data on Process Available
  - Consistent Composition
  - Available Year Around
  - Easily Stored and Stable

Design Basis

- 2000 Dry Metric tons/day of Biomass
- Ethanol Production, 55+ MM gallons/year
- For Corn Stover
  - Collection would be within a 25 mile radius.
    - 1.5 T/acre, 50% Acreage in Corn, 75% Land Available

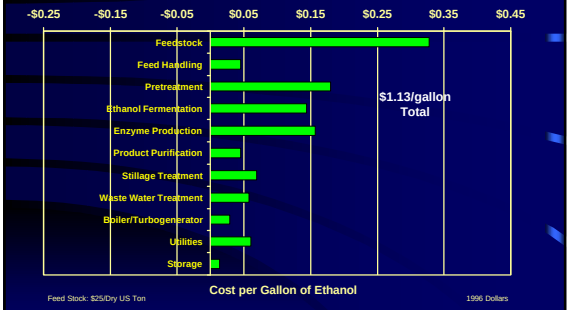
Bioethanol Production via Dilute Acid Pretreatment & SSCF

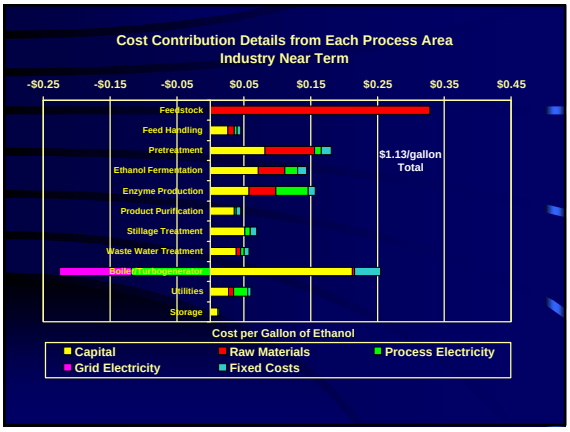


"Near Term" Process Design

- NREL - Near Term
  - Most aspects of the design have been experimentally tested at NREL.
- Industry - Near Term
  - Design conditions are from literature/patents and industrial contacts.
  - Assumptions for process integration.

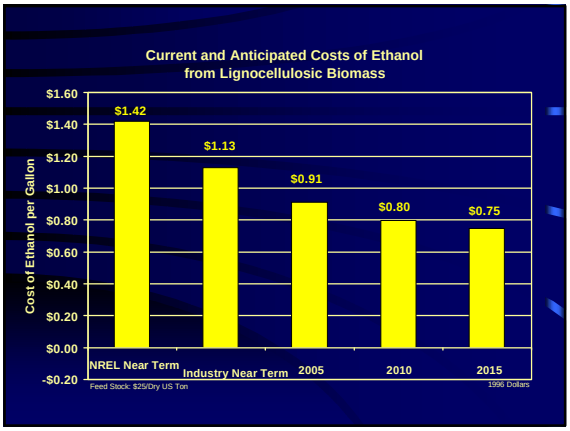
Cost Contribution from Each Process Area Industry Near Term

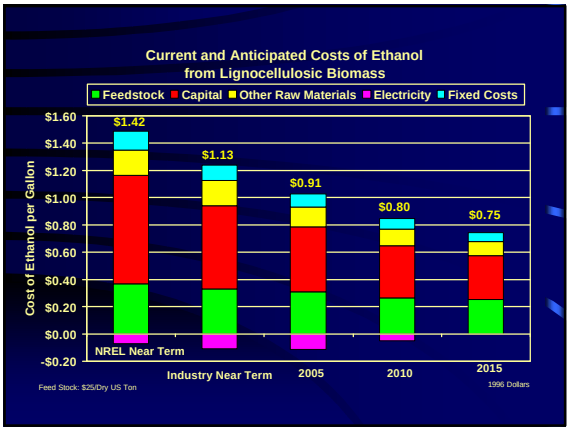


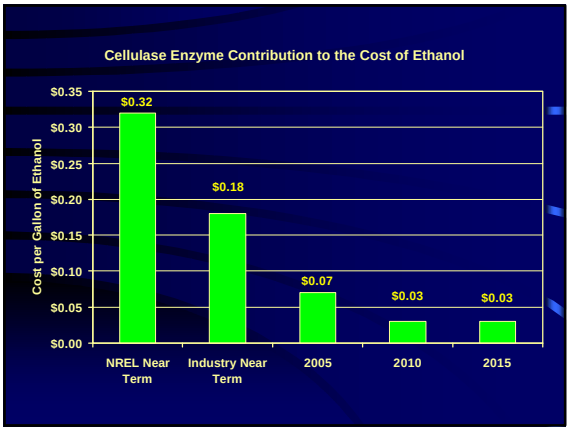


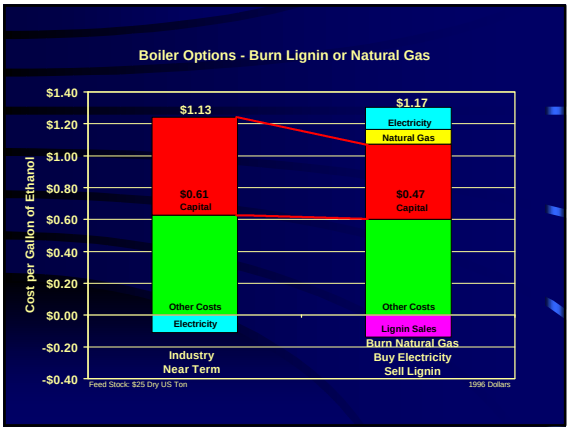
Anticipated Improvements

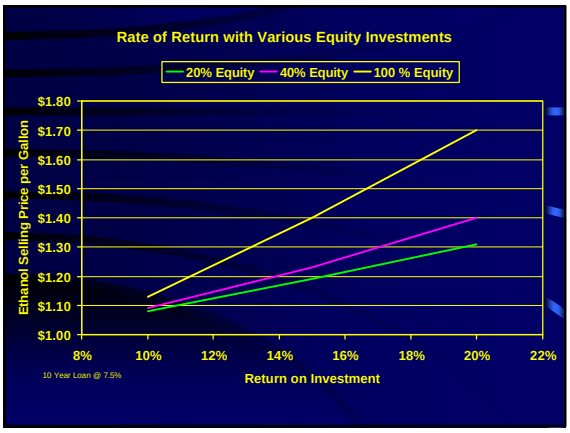
- 2005
  - Higher yields of Hemicellulose in Pretreatment & lower capital costs.
  - Higher temperature Ethanol Producing Microorganism.
  - Cellulase enzyme activity improved by a factor of 3.
- 2010
  - No hydrolyzate Detoxification.
  - Cellulase enzyme activity improved by a factor of 10 over "Near Term".
  - Higher Saccharification yields, using higher enzyme loading.
  - Further optimization of fermenting microorganism.
- 2015
  - Increased carbohydrate level in feed.











Continuing Work

- **New Engineering Consultant Studies**
  - **Pretreatment Reactor Design and Costs**
  - **Liquid/Solid Separator Performance and Costs**
- **Enzyme Reactor Design and Costing**
  - **Efforts will be underway soon to address the design and cost of very large scale enzyme production.**
- **Lignin Utilization**
  - **DOE is sponsoring research to convert lignin to useful fuel additives. Gasification will also be modeled as an alternative to simple combustion.**

Acknowledgment

- This work is sponsored by the Office of Fuels Development in the Office of Transportation Technology at the U.S. Department of Energy.